A Focus on Offshore Safety: Recent Reports by the Marine Board of the National Research Council

Topical Review of Reports Issued
from January 1, 1994 through December 31, 1996

by the following committees which operated under the auspices
of the Marine Board of the National Research Council

Committee on the Safety of Marine Pipelines
Committee on the Role of Technology in Marine Habitat Protection and Enhancement
Committee on Techniques for Removing Fixed Offshore Structures
Committee on Undersea Vehicles and National Needs

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Abstract

During the last three years, the Marine Board of the National Research Council (NRC) has published four study reports that focused on enhancing safety in offshore oil and gas activities and in the marine and maritime fields. The objective of these studies was to provide recommendations for actions that will reduce or eliminate deaths and injuries, reduce pollution from accidents and operations, and protect resources and structures from loss. Several recurring themes are woven through many of these reports. The themes deal with using technology already available and demonstrated, using risk analyses to establish priorities for use of resources (such as inspection facilities and personnel) despite the lack of data for decision making, using advanced tools for inspection and monitoring, and using long-term monitoring to gauge performance.

One report about improving marine pipeline safety describes the safety challenges associated with designing, regulating, and monitoring over 20,000 miles of underwater pipelines in federal and state waters. The report on the restoration and protection of marine habitats comments on the institutional, regulatory, and managerial impediments to the wider application of the best engineering technologies and practices and the ways to deal with these impediments. The report on assessment techniques for removing offshore structures provides guidance on the use of technologies and their associated hazards and the development of strategies to mitigate environmental damage when offshore structures must be removed. One of the most recent reports describes a concept for using present undersea vehicles technology and systems to perform tasks that respond to the need to monitor the condition of offshore pipelines and seabed facilities. Two studies now underway continue several of the themes noted in aforementioned reports: one theme being a review of the uses of risk assessment opportunities in an effort to find useful experience from other industries. Another current study targets the introduction of human performance and organizational system theory and practice from other industries into the maritime and offshore industries.

These studies were sponsored by the U.S. Department of Energy's Federal Energy Center Contract DE-AI21-94MC31164 with the Maritime Administration of the Department of Transportation which serves as the administrative agency for the federal government under Cooperative Agreement No. DTMA91-94-G-00003 between the Maritime Administration and the National Academy of the Sciences.

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Executive Summary

The safety record in offshore operations in U.S. marine waters—as reflected by less environmental pollution and loss of fossil fuel resources, less damage to facilities, and the decreasing numbers of injuries and deaths—has been a good one during the last five years, compared to the 1970s and early 1980s. With few exceptions, this record reflects the industry's proactive safety mentality and the understanding that safety is the primary responsibility of the operator and other personnel working on pipelines, platforms, and support facilities. There are opportunities to improve this record, e.g., actions can be taken to enhance the safety environment that include appropriate and useful regulations and commitment of resources for their enforcement. Four reports by the Marine Board of the National Research Council address preventative measures and technology that should be considered by industry and government to assure continued good safety performance in the face of expanding (e.g. long pipelines, some over 100 km) and deeper offshore operations (with development and production moving beyond 1,000 meters or 3,000 feet) as well as a large number of aging facilities (e.g. over 100 platforms removed per year).

In safety planning—e.g. designing new facilities, assigning inspection resources—data bases for decision making will often be lacking, but modern risk assessment analyses, using incomplete data supported by inferences and expert opinion about the nature and distribution of risks, can clarify priorities for risk management. Inspection and monitoring of facilities and projects should be a part of long-term planning and performance including pipeline integrity and the condition of their burial, restoration of coastal habitat, and the effects of offshore structure removal operations on the surrounding fish life.

Regulations should be modified to improve the safety performance of platform removal. If the requirement for severing platform legs is changed from the current 15 feet below the mudline to 3 feet, environmental harm from the use of explosives is likely to be reduced, danger to divers is likely to be reduced, and removal costs will be reduced. In part as a result of recommendations in the report on pipeline safety, the Department of the Interior and the Department of Transportation have established an agreement on their offshore pipeline jurisdictions and the use of the inspection facilities.

Overall, more information and data are needed in databases (action is underway to improve databases by the Minerals Management Service of the Department of the Interior), about accident and pollution causes including human-performance data as well as data about the effects of ocean engineering activities to enable realistic goal-setting in projects to restore and protect marine habitat.

Introduction

Since its inception in 1965, the NRC's Marine Board has focused much of its program of studies and workshops on providing advice to industry and government about ways to enhance the safety of offshore oil and gas operations. The objectives of Marine Board studies, workshops, and reviews were and continue to be to recommend actions that will reduce if not eliminate injuries and deaths, reduce pollution caused by accidents and operations, and protect resources and facilities from loss.

During the rapid growth of offshore oil and gas development and production in the Gulf of Mexico in the 1970s and early 1980s, NRC recommendations were a major influence in the development of safety and inspection standards for offshore platforms. Today, with modern survey and drilling technologies, the Gulf of Mexico is again in the midst of resurging development, much of it in deep water (>1,000 meters or 3,000 feet) and applying these new technologies to more efficient use of near shore reservoirs. This development presents technical and safety challenges inherent with greater depth of completions and production, longer pipelines, greater distances from onshore support centers, and the problems related to integrating new development with older systems and facilities. While new offshore platforms and pipelines catch industry and public interest, earlier offshore development in the Gulf of Mexico—and to a lesser degree in the Southern California Bight and Alaska—has provided an impressive investment in a network of platforms and pipelines that will need increasing attention as they age. The mere numbers of these facilities speak to the size of the investment that must be maintained, safely operated, or—in many cases— retired within the next few years:

- Over 32,000 km (20,000 mi.) of underwater pipelines in federal and state waters that carry nearly one-fourth of the nation's natural gas produced and one-ninth of its crude oil. Many of these lines that lace the shallow waters of the Gulf of Mexico are over 30 years old.

- Approximately 3,800 platforms are in federal and state waters; more than a quarter of these are over 25 years old.

Since early 1994, the Marine Board has published four studies about pipeline safety, developing undersea vehicles for scientific and industrial applications, restoring and protecting marine habitat, and removing offshore structures. These studies focused on several issues posed by new offshore development as well as how to deal with maintaining, operating, and retiring facilities while assuring continued good safety performance. In addition, the Marine Board is engaged in several activities that build on the conclusions and recommendations of these studies.

While direct concern with offshore safety in regard to the protection of personnel and the environment is an explicit part of the missions of the Minerals Management Service of the Department of the Interior, the Office of Pipeline Safety of the Department of Transportation, and the U.S. Coast Guard, and other agencies also have a major interest in assuring a continued good safety record in concert with industry. Specifically, the U.S. Department of Energy—one of the

10[1] agencies supporting the NRC/Marine Board studies—has, as part of its mission, responsibility for support of research and studies to ensure and enhance the nation's supply of fossil fuels.

While the major focus of recent safety-related NRC/Marine Board reports involving the offshore oil and gas industry has been on the Gulf of Mexico, the reports' findings and recommendations are applicable to other offshore sectors in U.S. federal and state waters, including Alaska. The discussion below tells how the advice in these reports relates to government and industry activities to improve safety offshore.

Issues

Several safety-related issues emerge in these recent Marine Board studies and reports as well as in current safety-related studies and activities. The following appear to be the most cross-cutting:

- How to estimate and establish priorities for the commitment of resources to monitor and inspect offshore systems and surrounding environments to enhance safety? This concern is amplified by the frequent lack of accident or environmental change data to guide decision-making.

- How can existing technology and data, including knowledge about human performance, be used more effectively for accident or pollution prevention in offshore operations and the restoration and protection of coastal areas?

- How do regulations influence commitment of resources affecting safety performance and are there opportunities to make regulatory changes to enhance use of enforcement resources?

[1] As of March 1, 1997, agencies supporting the NRC/Marine Board studies through the cooperative agreement listed later in this report, are: Department of Energy; the Department of Commerce's National Oceanic and Atmospheric Administration; Department of the Interior, Minerals Management Service and U.S. Geological Survey; Department of Transportation, Maritime Administration, and U.S. Coast Guard; Environmental Protection Agency; National Science Foundation; and the U.S Army Corps of Engineers' Directorate of Civil Works and the Waterways Experiment Station. The U.S. Fish and Wildlife Service also supported work done on habitat protection before 1997.

Discussion and Results of Studies

Improving the safety of marine pipelines

Improving the Safety of Marine Pipelines (NRC, 1994a), is the study report of a multidisciplinary review and assessment of the technical, regulatory, and jurisdictional issues that affect the safety of pipeline operations in marine federal and state waters. This study was conducted by a committee, operating under the auspices of the Marine Board of the NRC, to provide advice in response to requests by the Minerals Management Service (MMS) of the Department of the Interior and the Office of Pipeline Safety (OPS) of the Department of Transportation to gain a fresh perspective on offshore pipeline safety risks and the means to reduce or eliminate them.

The overall safety record of marine pipelines has been a good one; but, it can be improved. However, despite improvements during the 1990s, transmission and production pipeline leakage and accidents accounted for about 98 percent of all oil spilled by OCS oil and gas operations. While the attitude of employees and management toward safety remains the greatest influence on reducing accidents and pollution, improvement also depends on better information to put safety planning on a sound basis. This information is difficult to obtain because several agencies have different reporting formats and information requirements. No agency coordinates the collection of information, and the available data on offshore pipeline failures are correspondingly incomplete. Therefore, the committee recommended that the agencies involved (MMS and OPS) develop a safety database that covers both state and federal waters and periodically review their data requirements. Since this report was published, the MMS has extended its coverage and investigations of offshore accidents and spillage, and it now has the most comprehensive safety data and reporting process for the offshore areas where the oil and gas industries operate.

In the absence of better safety data, safety planning can be improved. Modern risk analysis methods, using incomplete data supported by inferences and expert opinion about the nature and distribution of risks, can clarify priorities for risk management. For example, the risks to human safety and to the environment due to failures of marine pipelines are not uniform across the Gulf of Mexico. (Nor are risks uniform in the offshore waters of Southern California and Alaska.) One element that can affect pipeline failure is the rate of shoreline change and its effect on the depth of water over pipelines in a given sector of the coast. Figure 1 illustrates a portion of the Louisiana-Mississippi coast and its rates of shoreline change in meters per year of accretion or erosion.

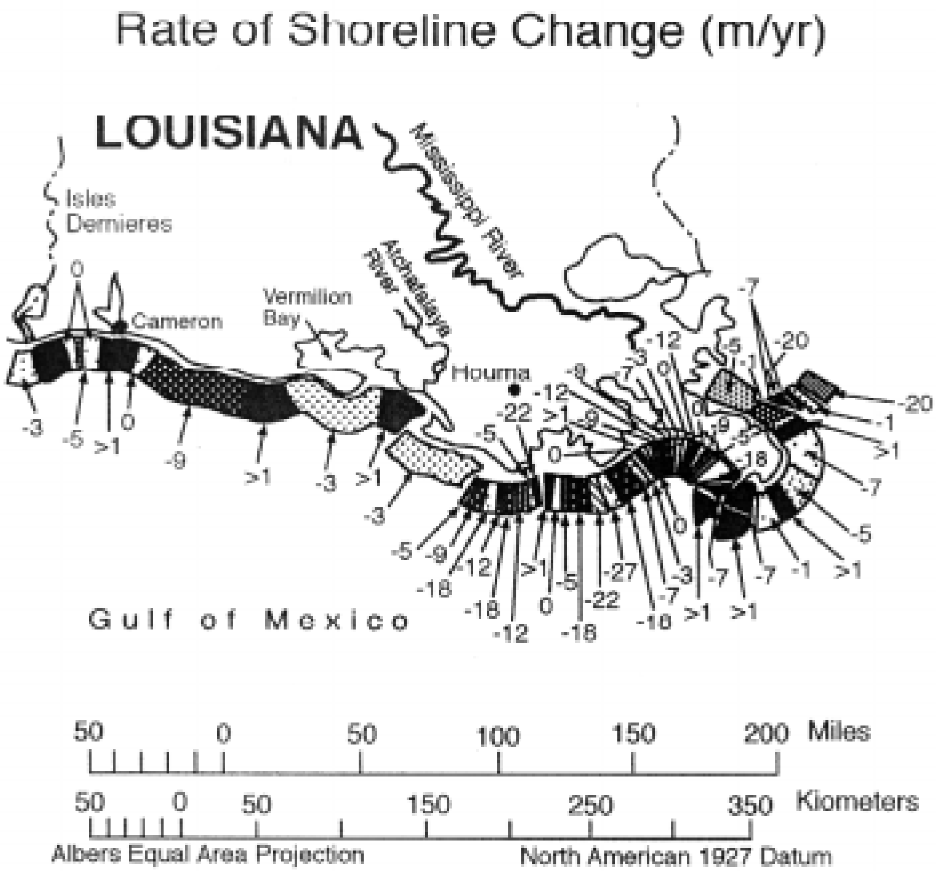

FIGURE 1. Map of the Louisiana and Mississippi sectors of the Gulf of Mexico shoreline, showing rates of shoreline erosion and accretion (meters per year). (Louisiana Geological Survey, 1991)

Resources being limited, a risk analysis approach that compares risks in different geographic areas (or "zones") would allow cost-effective risk management decisions. In this way, regulations can be developed to address safety everywhere and provide the basis for strengthening regulations in high-risk areas. The committee recommended that safety regulations be based on sound risk analysis and cost-benefit analyses. Specifically, regulatory agencies should agree on a consistent risk management strategy to set priorities on human safety criteria and the use of cost-benefit analysis for the reduction of property and environmental damage. A zone-based risk analysis model should be developed on the basis of currently available information and then regularly updated to determine whether regulations should be revised, strengthened, or relaxed and to assist in establishing priorities for the operational use of resources by both government and industry for enhancing pipeline safety (such as inspection coverage and frequency, use of internal inspection devices, and establishment of burial depths for areas having high erosion rates).

Figure 2 shows an example of a mini-zone partition for a hypothetical region. In this case, five parameters have been introduced: surface area in square miles (or kilometers), density of pipelines (indexed by *j)*, the density of vessel traffic (indexed by *k* and possibly the types of vessels if there are significant differences in drafts), water depth (indexed by *l*), and the number of platforms. The structure of the risk analysis model includes (a) initiating events (e.g. a vessel-pipeline collision) and annual probabilities; (b) intermediate developments and their probabilities conditional on the initiating events (e.g. the probability of a fire given a vessel-pipeline allision); and (c) the consequences (generally expressed as means or mean rates) of each accident sequence. The report *Improving the Safety of Marine Pipelines* (NRC, 1994a) provides a detailed description of the development and structure of a risk analysis model based on zonation.

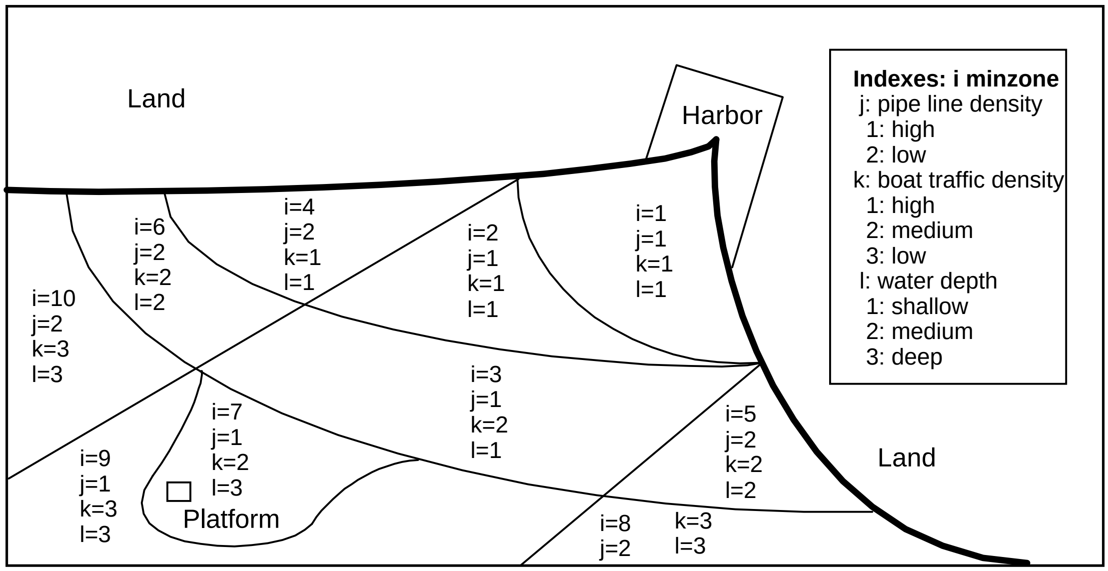

FIGURE 2. Partition of a hypothetical area according to water depth, pipeline density, and boat traffic density.

While, to date, there is no evidence of a risk analysis approach that uses a zonation model being employed in offshore facilities or regulatory planning application by government agencies, there are plans to apply a similar approach to some OPA-administered pipeline regulations for land pipeline locations in high population density areas. The MMS is considering using risk assessment methods to evaluate the safety of offshore structures, particularly to focus available inspection forces on those operations and operators that pose a greater risk of exposing the public and environment to risks such as an oil spill. International interest in the use of risk assessment methods for marine systems is also reflected by the American Bureau of Shipping which recognizes a role for ship classification societies in the use of these risk assessment methods. Reflecting the interests of these organizations and others, the NRC convened a committee to conduct the following tasks and issue a report in the fall of 1997:

- review and identify available methodologies for conducting engineering risk assessment useful to marine safety management;

- identify public and proprietary databases and assess their usefulness for risk assessment; and
- conduct case studies, including an evaluation of risk assessment methods used in several current risk assessments of offshore platforms.

Improving the Safety of Marine Pipelines, also notes that enforcement of safety regulations is impeded by a lack of coordination among agencies. This situation is largely related to the great differences in scope and approach of enforcement programs of the OPS and MMS, with OPS being responsible for over 2.7 million kilometers (1.7 million miles) of interstate and intrastate pipelines on land and under U.S. waters. The marine portion of OPS responsibility is small, about 21,000 kilometers (13,000 miles) of pipelines (in the Outer Continental Shelf [OCS] sector). Pipelines in this area are a low risk to public safety compared to land pipelines. In contrast, MMS has 6,500 kilometers (4,000 miles) under its jurisdiction, but it has a great preponderance of OCS inspection staff and resources. Moreover, the MMS has responsibility for overview of safety regulations on most of the platforms where personnel are located. The committee recommended actions to make better use of inspection resources and integrate enforcement of MMS and OPS marine pipeline safety regulations. Partly due to this recommendation, the two agencies have recently established a memorandum of understanding ((MOU) Federal Register, February 14, 1997) to implement a clearer delineation of production (Department of the Interior/MMS) and transportation (Department of Transportation/OPS) lines and agency jurisdictions. In addition, the MOU provides general guidance about how enforcement resources (i.e., inspectors, helicopters) are to be shared.

The report addresses the need for periodic inspection of pipelines as well as the need for geotechnical studies of soil conditions with sampling at intervals determined by local site conditions. While internal pipeline inspection can be done in some lines by the use of devices called “pigs”, external inspection and monitoring beyond diver depth is time-consuming and expensive. Vehicles that can perform external pipeline inspection and obtain some types of geotechnical samples have been investigated by another committee of the NRC/Marine Board. Its findings are given in the next section of this report.

Undersea Vehicles and National Needs

The recently published NRC report, *Undersea Vehicles and National Needs* (NRC, 1996a), was produced in response to interests expressed by several federal agencies[2] with mission-related efforts to find better ways to obtain data and samples from remote and, at present, inaccessible sectors of the ocean or to perform more efficiently work tasks for science or industry within the ocean or on the sea bed. A key section of this report addresses a conceptual view of how to use mostly existing technology in a new vehicle system to provide either or both inspection and intervention (work tasks) functions in offshore applications.

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[2] These agencies are: the National Oceanographic and Atmospheric Administration, National Undersea Research Program; National Science Foundation; U.S. Navy’s Office of Naval Research and the Deep Submergence Office (N879); and the Defense Research Projects Agency.

To be able to undertake production operations at least cost in the deeper waters of the OCS, the U.S. oil and gas industry is turning from fixed or floating platforms to “subsea completion systems.” With this technology, a “satellite” unit operates on the sea floor with a platform of its own. These satellite installations include seafloor templates and wellheads and are within oversight proximity to a central production platform, which can be up to 46 kilometers (25 nautical miles) away. Each production platform can handle a number of satellites. Satellite units direct the oil or gas through a pipeline along the sea bed to the central platform.

Satellite installations and their pipeline connections require periodic inspection and intervention for continued, reliable operation. Presently this involves leasing a support vessel outfitted with a remotely operated vehicle (ROV) system, with the possible addition of a towed sensor to inspect flowlines and control cables. An autonomous underwater vehicle ((AUV) a vehicle without cable or control line link to the surface) could perform satellite and pipeline inspection and intervention tasks by operating from the central platform and making excursions to the wellhead sites. The AUV would eliminate the need for leasing an expensive surface vessel (at approximately $20,000 per day [1995 rates], and it would be able to survey pipelines and control cables linking the central platform with the satellite subsea wellheads while in transit to or from the satellite. Moreover, response to unplanned and emergency situations would be more rapid than using surface vessels traveling from a shore service site.

Figure 3 illustrates a concept of an oil field service AUV that would be “garaged” at the central platform and would be capable of operating autonomously or under supervisory control of an operator on the platform. At the satellite, the vehicle would connect to a fiber-optic link permanently installed in the satellite for operation and feedback in the supervisory mode. The vehicle could perform detailed observation and intervention of the satellite with an operator in the control loop in real time if the system had an advance telemetry link via an acoustic modem or a lightweight fiber-optic tether. The vehicle would then transit back to the platform autonomously; it could also return on its own at any time during the mission in case of a loss of communications. This vehicle is envisioned to have a range of 93 kilometers (50 nautical miles) for a round trip mission, a speed of 6 knots maximum, and mission duration of 36 hours (maximum). The basic technology supporting the AUV design concept and operation has been demonstrated. However, further development will be required in adapting advanced battery technology (developed in other industries); integrating sensors, navigation, and control subsystems; and adapting magnetic sensors to AUV operation.

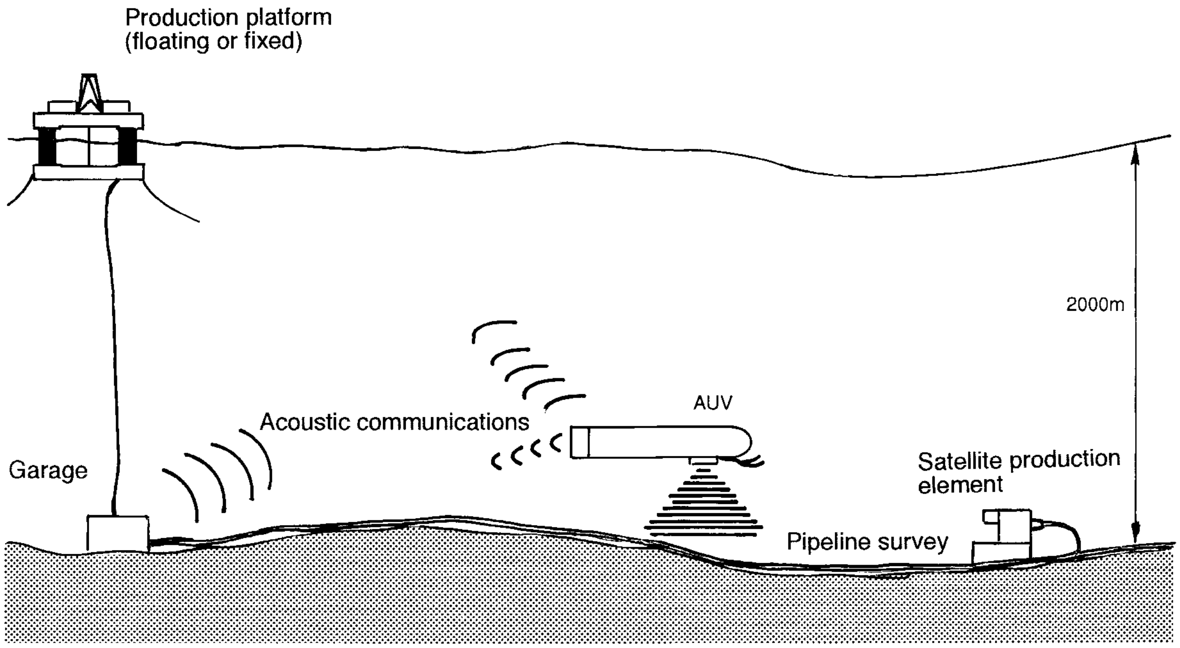


FIGURE 3. Subsea Oil Field Inspection and Intervention Vehicles Concept.

Restoring and Protecting Marine Habitat

The report *Restoring and Protecting Marine Habitat: the Role of Engineering and Technology* (NRC, 1994b) was prepared by a committee of the NRC/Marine Board to determine the need to explore the role of coastal engineering in enhancing and restoring marine and estuarine habitats and contiguous shorelines with the coastal zone. The extraordinary changes that have occurred and continue to occur take place in the nation's coastal habitats. This action was prompted by growing concerns by government, industry, and environmental interests, about the extraordinary changes that have occurred during this century in the nation's coastal habitats. The committee also was asked to determine what management efforts have been undertaken, if and how they have succeed, and what future needs and opportunities may arise to restore and enhance habitats through engineering approaches. Although the Gulf of Mexico coast is not uniquely affected by habitat losses, one inducement to pursue the study was the fact that, until recently, about 30 square miles of Louisiana land disappears annually (depending on the estimate used) into the sea.

Conversion, alteration, and loss of marine habitat are both a consequence and symptom of coincidental developments that include:

- a concentration and continuing growth of human populations in the coastal zone;
- a proliferation of industrial and residential shoreline development;
- human activities that degrade water quality;
- increasing commercial and recreational use of marine and estuarine areas;
- development of natural resources in the coastal zone;

- physical changes in the environment, including subsidence, elevation, and sea level changes; and
- construction and maintenance of port and waterways systems and operation of associated commercial vessels.

Industrial activities, including offshore oil and gas development, are or can be major direct or indirect contributors to the above causes and symptoms; but, the committee determined that much can be done with existing habitat knowledge and engineering expertise to enhance, protect, restore, and create marine habitats. Considerable scientific and engineering effort is already being applied, although not always harmoniously. Many habitat projects are performing well. Other projects may be functioning according to design, but lack the monitoring necessary to document performance. An integrated, holistic approach that recognizes engineering practices and capabilities as well as the functions of marine ecosystems and their habitats is especially important. The principal obstacles to wider use of coastal engineering capabilities in habitat protection, enhancement, restoration, and creation are the institutional, regulatory, and management barriers to using the best available technologies and practices.

The few economic incentives for marine habitat protection and restoration by the private and industrial sectors present another obstacle to the more effective use of coastal engineering approaches to habitat management. Moreover, regulators and practitioners are often not sufficiently qualified to guide application of habitat protection and restoration technologies.

The report notes that there are no universally accepted measures against which to gauge performance or direct the evolving state of practice. Project sponsors should commit to long-term maintenance and monitoring sufficient to provide the data necessary for determining project performance, indicate any necessary corrective action, and encourage accountability. Substantial restoration research has been undertaken but often on a project-by-project, opportunistic basis rather than through a systematic program designed to fill gaps in knowledge and technology. Often national research efforts have not been coordinated to conserve and maximize use of research resources.

The committee made an overall recommendation, that the executive and legislative branches of the federal government should establish a national policy to prevent, or where development is considered in the national interest, offset, the further degradation, conversion, and loss of marine habitat. The policy should specify goals and establish a time frame for achieving them.

From a broader viewpoint, as a post-script to the discussion concerning the above study and report, it may be observed that there may be a link between the process of goal setting in coastal restoration and protection planning and the risk analysis process noted in the NRC/Marine Board report on *Improving the Safety of Marine Pipelines* (1994a) discussed earlier in this report. Another commonality between the two reports is the need to acquire, record, and manage site-specific or local environmental data that are likely to be used for engineering analyses for planning significant coastal engineering activities whether they are for habitat protection or for facilities construction, installation, inspection, and removal.

An Assessment of Techniques for Removing Offshore Structures

The report, *An Assessment of Techniques for Removing Offshore Structure* (1996b), was issued in response to a request for an assessment about whether current MMS requirements and practices governing removals are adequate to protect living marine resources, particularly with respect to the use of explosives. As noted earlier, there are approximately 3,800 platforms in federal and state marine waters; Figure 4 shows their numbers by age. The total number of offshore platforms has recently remained steady, with the annual rate of new installations being about equal to the number being removed. However, the characteristics of modern platforms that may relate to the engineering methods to be used and environmental influences resulting from their eventual retirement are greatly different from the platforms installed over 30 years ago. Those older platforms were placed in shallow water, were smaller, and usually supported less complex processing or pumping equipment. Deep-water platforms are much more expensive to remove and costs will inevitably increase. The committee estimated that by the year 2000, industry will spend more than $300 million per year for platform removals.

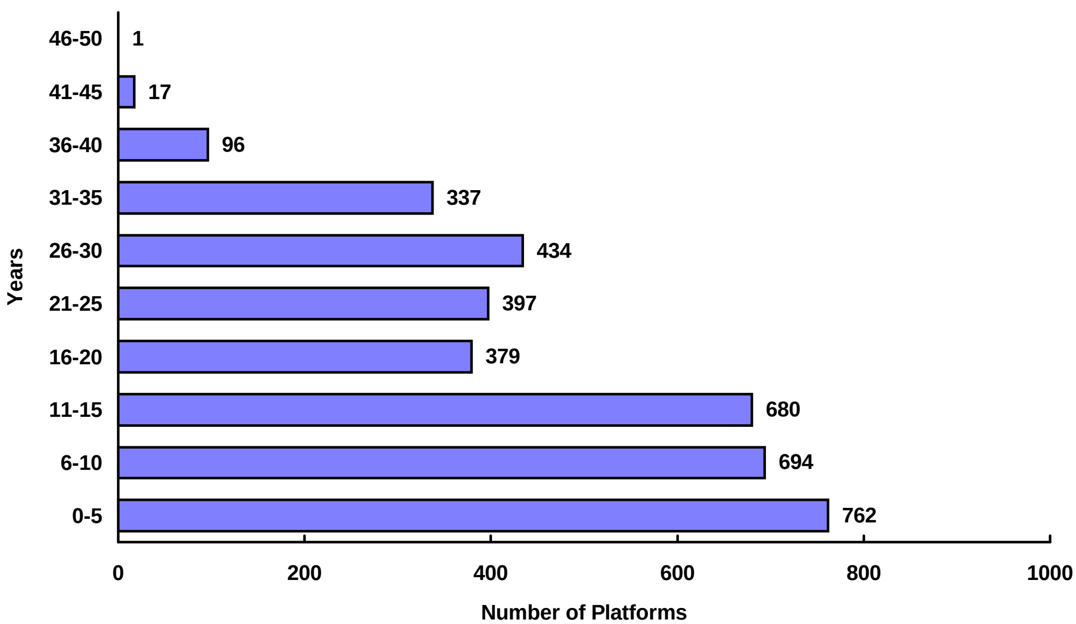
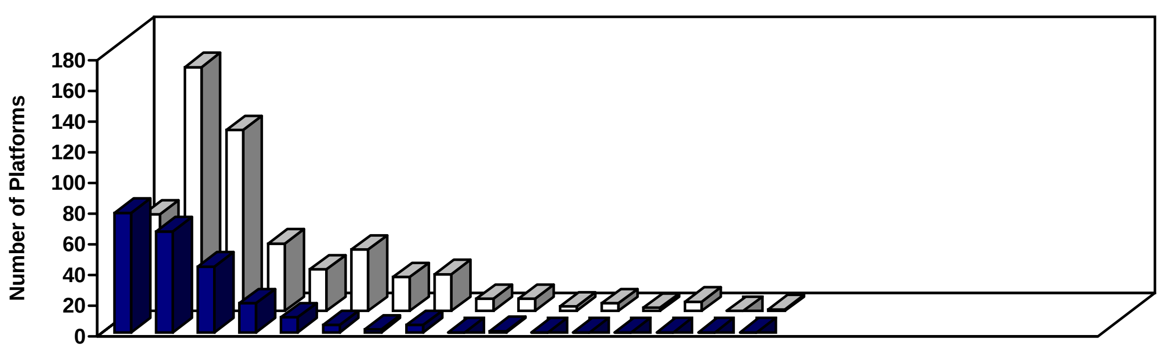


FIGURE 4. Number of existing platforms, including caissons, by age.
Source: Courtesy of Minerals Management Service.

On the basis of its own reviews, information, and data provided in presentations by experts on explosive and non-explosive removal techniques, regulatory representatives from federal and state agencies, scientists who have or are conducting research on the ecology of the Gulf of Mexico, and representatives of environmental organizations, the committee found sufficient common ground to recommend a framework for improving the platform removal program. They concluded that there are significant opportunities to satisfy concerns of all interested parties without slighting the concerns of others. To take advantage of these opportunities, regulations must allow for individual circumstances and conditions.

Figure 5 illustrates the water depth and type of removal technique (explosive or non-explosive) employed for removals during the period 1985 through 1994. The major conclusions centered on the use of explosives and the required depth below the mudline for cutting structures or well conductors. The committee concluded that explosives are an economical and reliable tool for removing most structures, especially structures located in deep water, and at this time there is insufficient information about the mortality of fish from explosive removals. They also noted that the 15-foot depth requirement is a disincentive to the development and use of nonexplosive techniques and advanced techniques using smaller explosive charges. As a result, a recommendation was made to change the minimum depth at which structures must be severed below the mudline from 15 feet to 3 feet, provided that platform removal measures are employed that do not increase adverse environmental effects. Other recommendations addressed the need to allow for a flexible permit process to encourage the testing of removal techniques, partial removal of structures in approximately 100 meters (300 feet) of water, working with industry in the development of implementation techniques, the use of acoustic techniques to keep fish at a relatively safe distance, and the design of structures that would enhance safer removal and reduce environmental damage.



Water Depth Range (ft)	80	165	245	330	410	500	575	650	740	820	900	1000	1060	1150	1230	1310
■ Non explosive	78	66	43	19	10	5	2	5	0	1	0	0	0	0	0	0
□ Explosive	63	159	118	44	27	40	22	24	8	8	3	5	2	6	0	1

FIGURE 5. Number of platform removals, excluding caissons, by method and water depth (1985-1994). Source Courtesy of Minerals Management Service.

Many reports on safety in both maritime and offshore operations affirm that the majority of accidents are human error—e.g., falling through open hatches, down stairs, or off platforms. Crane operation is the second largest cited type of accident environment; but, the basic cause(s) of the accident is seldom known or understood. The design of the offshore facility not consider how easily fires can be started and propagated and place maintenance areas too close to combustible material storage. Inadequate safety design may locate pipelines near platforms thus increasing the high risk of anchor damage from service boats. Increasingly, both government and industry realize that human beings use what is built or designed, and human capabilities and limitations must be considered in when designing successful systems.

In recognition of the important role of human performance and organizational systems in operating marine systems safely and reliably, the Marine Board is conducting a workshop series to integrate theory into practice and to transfer the best methods and processes from other industries and disciplines into the marine, maritime, and offshore industries.

Conclusions

Overall the offshore safety record is a good one with proven safety-related procedures and systems in place supported by workable regulations. This safety performance has been largely a product of the commitment of operating personnel and management. However, many of the of facilities—mostly platforms and pipelines in the Gulf of Mexico—are near or past their original design life. While much more is now known about the condition of these structures, and system maintenance and monitoring can often increase their service life, greater vigilance will be needed backed by the use of advanced monitoring and inspection tools.

In response to concerns about how to deal with the large number of aged platforms that are no longer economically useful, more flexible requirements for their removal, including reducing the severance depth below the mudline to 3 feet, will enhance removal safety and possibly reduce environmental damage and cost.

The databases available from both government and industry often lack the engineering-related information and environmental data that is essential to the commitment of safety-related resources and application or development of safety regulations. Even without desired data, safety planning can be improved by use of modern risk analysis, and priorities for risk management can be clarified. This does not obviate the need for engineering-related information and environmental data about sites where new facilities are likely to be placed or marine habitats may be protected or restored.

Adequate provision for inspection and monitoring is essential in offshore and coastal project planning and implementation; yet, these elements are often missing or their availability is too short-term to be useful in determining success. This is particularly the case with coastal habitat and coastal engineering projects.

References

Louisiana Geological Survey. 1991. Historical Shoreline Change in the Northern Gulf of Mexico. Project Coordinator: S. Penland. Prepared for the Coastal Erosion Subcommittee, U.S. Environmental Protection Agency, Gulf of Mexico Program by the Louisiana Geological Survey in cooperation with the Texas Bureau of Economic Geology, Mississippi Office of Geology, Geological Survey of Alabama, Florida Department of Natural Resources, and U.S. Army Corps of Engineers—Jacksonville District. Louisiana Geological Survey, Baton Rouge, Louisiana.

NRC (National Research Council). 1994a. Improving the Safety of Marine Pipelines. Committee on the Safety of Marine Pipelines. Marine Board, National Research Council. Washington D.C.: National Academy Press.

NRC. 1994b. Restoring and Protecting Marine Habitat: the Role of Engineering and Technology. Committee on the Role of Technology in Marine Habitat Protection and Enhancement. Marine Board, National Research Council. Washington D.C.: National Academy Press.

NRC. 1996a. Undersea Vehicles and National Needs. Committee on Undersea Vehicles and National Needs. Marine Board, National Research Council. Washington D.C.: National Academy Press.

NRC 1996b An Assessment of Techniques for Removing Offshore Structures. Committee on Techniques for Removing Fixed Offshore Structures. Marine Board, National Research Council. Washington D.C.: National Academy Press.

Contract Information

Author Information. All reports discussed within this report were authored by their respective committees. These committees are listed on the cover to this report.

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